TP53130

National Semiconductor

TP53130 DTMF (TOUCH TONE®) Generator

General Description

The TP53130 is a low threshold voltage, ion-implanted, metal-gate CMOS integrated circuit that generates all dual tone multi-frequency (DTMF) pairs required in tone-dialing systems. The 8 audio output frequencies are generated from an on-chip 3.579545 MHz master oscillator. No external components other than the crystal are required for the oscillator. The TP53130 can be powered directly from telephone lines over wide range loop conditions. The device can interface directly to an inexpensive single-contact calculator type keyboard or a standard telephone 2-of-8 keypad *(Figure 4)*. The TP53130 is also capable of accepting binary code inputs for microprocessor-controlled systems applications.

Features

- 3V–15V operating voltage
- On-chip 3.579545 MHz crystal-controlled oscillator
- Tone accuracy better than ± 1% without tuning
- Interface with standard 2-of-8 telephone keypad
- Interface with single-contact low cost keypad
- Input signals can be in binary code
- Multi-key lockout with/without single tone capability
- On-chip high band and low band tone generators and mixer
- High band pre-emphasis
- Low harmonic distortion
- Open emitter-follower low impedance output
- Separate receiver mute and transmitter mute switch outputs
- Powered directly from the telephone line

Block Diagram

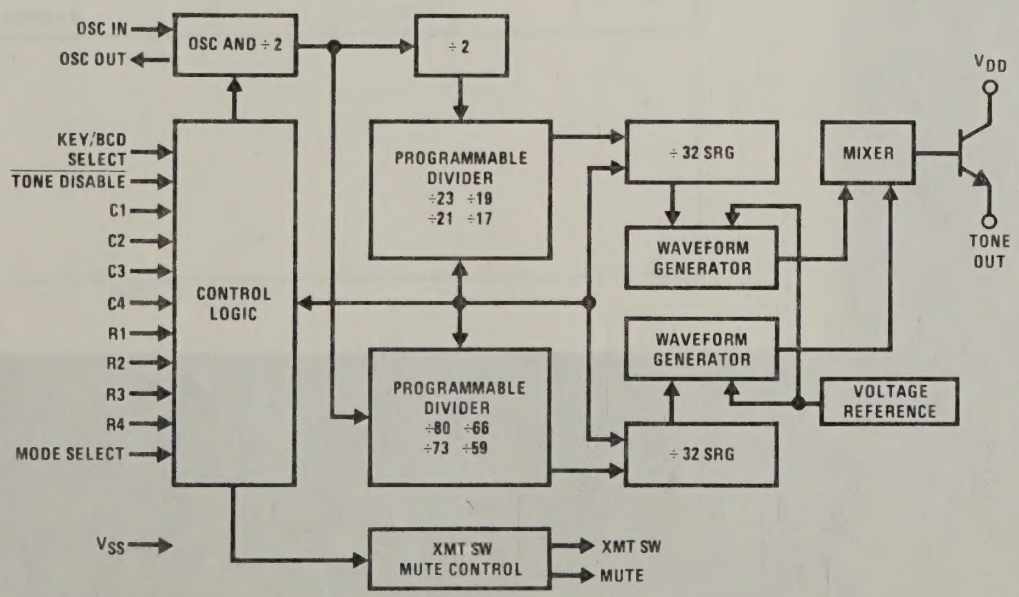


FIGURE 1

TOUCH TONE® is a registered trademark of Bell Telephone

Absolute Maximum Ratings

Voltage at Any Pin Except XMT SW and MUTE	$V_{SS}-0.3V$ to $V_{DD}+0.3V$
Voltage at XMT SW and MUTE Pins	$V_{SS}-0.3V$ to 15V
Operating Temperature Range	−40°C to +70°C
Storage Temperature Range	−65°C to +150°C
$V_{DD}-V_{SS}$	15V
Lead Temperature (Soldering, 10 seconds)	300°C

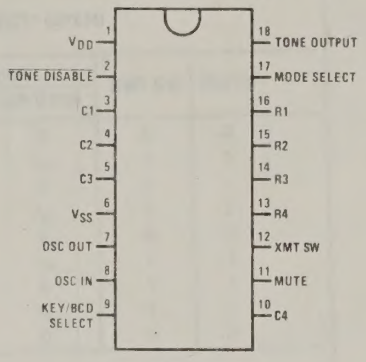
Electrical Characteristics T_A within operating temperature range, $3V \le V_{DD} \le 8V$, unless otherwise specified.

Parameter	Conditions	Min	Typ	Max	Units
Input Pull-Up Resistor					
Column and Row Inputs		25	50	90	kΩ
Key/BCD Select		200	650	1000	kΩ
Mode Select		200	650	1000	kΩ
$\overline{\text{Tone Disable}}$		200	650	1000	kΩ
Input Pull-Down Resistor					
Column and Row Inputs	$V_{DD}=3V$	650			Ω
	$V_{DD}=8V$	200			Ω
Input Voltage Levels					
Logical "1"		80% of V_{DD}		V_{DD}	V
Logical "0"		V_{SS}		20% of V_{DD}	V
Operating Frequency			3.579545		MHz
Output Voltage Swing at Tone Output					
Low Band Alone	$R_L>150\Omega$		820		mVp-p
High Band Alone	$R_L>150\Omega$		1000		mVp-p
Harmonic Distortion	$R_L>150\Omega$			−20	dB
Tone Frequency Deviation				1.0	%
Typical Application Output Level V_L (See *Figure 5*)	$20<I_L<100$ mA				
Low Band Tone	$R_L=150\Omega$		−7		dBV
High Band Tone	$R_L=150\Omega$		−6		dBV
THD	$f\le 20$ kHz		4		%
Output Currents	$V_{DD}=3V$				
XMT SW/MUTE	$V_{OUT}=2V$	3			mA
Idle Current	$R_L=\infty$, $V_{DD}=8.0V$ (No Key Depressed)			1	mA
Operating Current	$R_L=\infty$, $V_{DD}=3.5V$			2	mA
Key Down to Tone Outputting Time (Debounce)			3	4	ms
DC Output	Tone Disable = 0		TRI-STATE®		

TRI-STATE® is a registered trademark of National Semiconductor Corp.

Connection Diagram

Dual-In-Line Package



TOP VIEW

Order Number TP53130N
See NS Package N18A

FIGURE 2

Functional Description

A functional block diagram of the TP53130 is shown in *Figure 1*, and connection diagram is shown in *Figure 2*. The TP53130 can be operated in the Keyboard Interface Mode and can also be operated in the Binary Interface Mode depending on the logic level at the Key/BCD Select input. In either mode, the device will digitally synthesize the high and low band sine waves of DTMF signaling, when valid signals are applied to row and/or column inputs. The sum of the two sine waves is then provided at the Tone output.

Tone Disable: This input has an internal pull-up resistor. When this input is open or at logical high (V_{DD}), the XMT SW and MUTE outputs will deliver valid output signals in response to the proper input signals. When Tone Disable is at logical low (V_{SS}), the device will be in the inactive mode. Tone output will go to an open circuit state, XMT SW and MUTE outputs will sink current through on-chip N-channel devices and the crystal oscillator will be disabled.

Key/Binary Select: When this input is open or at logical high (V_{DD}), the device will interface a keyboard. (See Table I.) When Key/Binary Select is low (V_{SS}), the device will accept binary inputs on the row signal input lines. (See Table II.)

Oscillator: Tone generation and internal timing are dependent on the accurate operation of the crystal oscillator. The oscillator inverter/amplifier and all necessary bias networks are included on-chip. The only external component is a 3.579545 MHz crystal. It should be connected to the device as shown in the typical application diagram *(Figure 5)*. The oscillator is not running unless a valid input signal is applied to the device. The oscillator is also disabled when Tone Disable is tied to logic low (V_{SS}). This feature will prevent RF modulation on the telephone line.

Single Tone Capability: This is a desirable feature for initial testing. With the device operating in the Keypad Interface Mode, operation of multiple keys in different rows and columns will not generate output tones. However, operation of two or more keys in the same row or column will generate the proper tone for that row or column. During multiple key operation, the XMT SW and MUTE outputs will not change state more than once. With the device operating in the Binary Interface Mode, a logical low at the column 1 input will inhibit the high band tone output while a logical low at the column 2 input will inhibit the low band tone output. (See Table I.) Logical low inputs on both column inputs 1 and 2 will disable the device the same way as the Tone Disable input will when set to logical low.

Mode Select: This input has an internal pull-up resistor. When open or at logical high, single tone outputs are allowed. When this input is at logical low, single tone outputs are prohibited. XMT SW and MUTE outputs will stay high during a multiple key depression input.

Tone Output: Dual-tone output frequencies are generated in response to valid input signals to the device. (See Table III.) Each frequency is synthesized with 32 steps of approximation for low harmonic distortion. The amplitudes of the low and high frequency tones are constant and independent of operating voltages. When tone outputs are present, the Tone output will be the composite of the AC signal superimposed on a DC offset. The DC offset is approximately 1/2 V_{DD}. When no tones are present at the Tone output pin, the pin will be open circuit.

XMT SW (Transmitter Switch) and MUTE Outputs: In the idle state (no key depressed, no signal interface inputs and Tone Disable at a logical low) both the XMT SW and MUTE outputs will sink current to V_{SS} through on-chip transistors. In the active state, these outputs will source current from V_{DD} whenever valid output tones are generated. The MUTE output activates before the XMT SW output as shown in *Figure 3*.

Signal Inputs (Row and Column Inputs): These inputs do not have a fixed pull-up or pull-down internal resistor, or a fixed logical level. Logic levels at the inputs are determined by internal states of the device. An input scan technique is used so that the device can directly interface either 2-of-8 keypads with common switch arrangements or the single contact X-Y keypads. (See *Figure 4*.)

Functional Description (Continued)

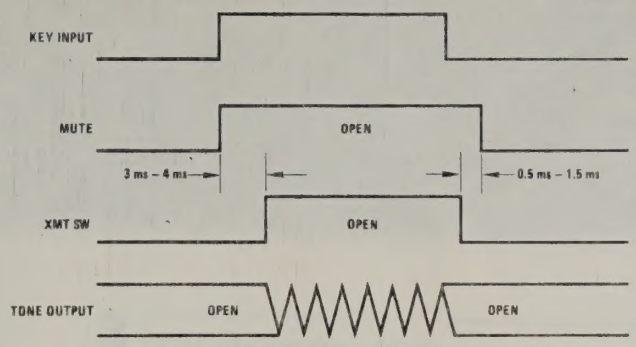


FIGURE 3. Timing Diagram of MUTE and XMT SW in Relation to Key Input and Tone Output

TABLE I. FUNCTIONAL TRUTH TABLE (WITH "MODE SELECT" OPEN)

Key/Binary Select	Tone Disable	Row	Column	Tone Output		XMT SW	MUTE
				Low Band	High Band		
X	0	X	X	0	0	0	0
1	1	One	One	f_L	f_H	1	1
1	1	One	Two or More	f_L	0	1	1
1	1	Two or More	One	0	f_H	1	1
1	1	Two or More	Two or More	0	0	0	0
0	1	Binary	Open	f_L	f_H	1	1
0	1	Binary	C1 = 0	f_L	0	1	1
0	1	Binary	C2 = 0	0	f_H	1	1
0	1	X	C1 and C2 = 0	0	0	0	0

TABLE II. FUNCTIONAL TRUTH TABLE FOR BINARY INTERFACE

Keyboard Inputs	Binary Inputs						Frequencies Generated	
	C1	C2	R1	R2	R3	R4	f_L (Hz)	f_H (Hz)
1	Open	Open	0	0	0	1	697	1209
2	Open	Open	0	0	1	0	697	1336
3	Open	Open	0	0	1	1	697	1477
4	Open	Open	0	1	0	0	770	1209
5	Open	Open	0	1	0	1	770	1336
6	Open	Open	0	1	1	0	770	1477
7	Open	Open	0	1	1	1	852	1209
8	Open	Open	1	0	0	0	852	1336
9	Open	Open	1	0	0	1	852	1477
0	Open	Open	1	0	1	0	941	1336
*	Open	Open	1	0	1	1	941	1209
#	Open	Open	1	1	0	0	941	1477
A	Open	Open	1	1	0	1	697	1633
B	Open	Open	1	1	1	0	770	1633
C	Open	Open	1	1	1	1	852	1633
D	Open	Open	0	0	0	0	941	1633
	0	Open	Valid				f_L	—
	Open	0	Binary				—	f_H
	0	0	Inputs				1/2 V_{DD}	1/2 V_{DD}

Functional Description (Continued)

TABLE III. OUTPUT FREQUENCIES

Inputs	Desired Freq. (Hz)		Actual Frequency (Hz)	Percent Deviation
	f_L	f_H		
R1	697		699.1	0.306
R2	770		766.2	−0.497
R3	852		847.4	−0.536
R4	941		948.0	0.741
C1		1209	1215.9	0.569
C2		1336	1331.7	−0.324
C3		1477	1471.9	−0.35
C4		1633	1645.0	0.736

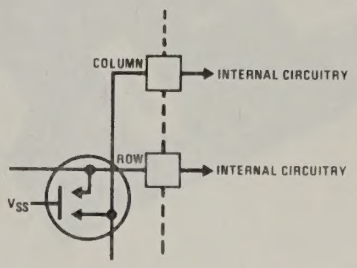


FIGURE 4a. Standard Dual Contact Telephone Key

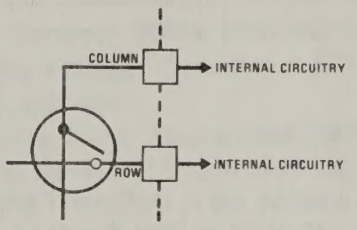
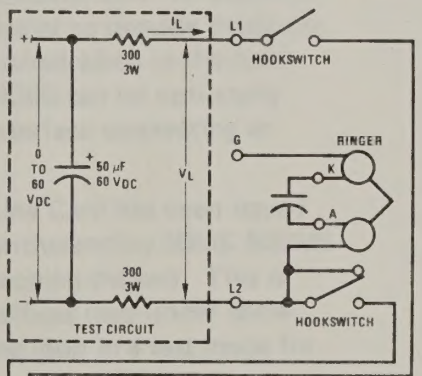


FIGURE 4b. Single Contact Key

Typical Application



Note 1: All resistances are in ohms.

Note 2: Test circuit used to measure signal levels and distortion.

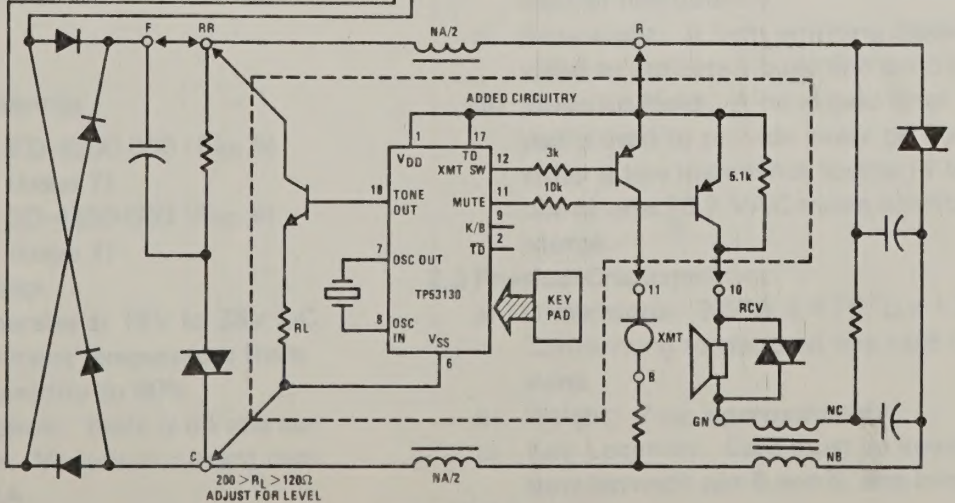
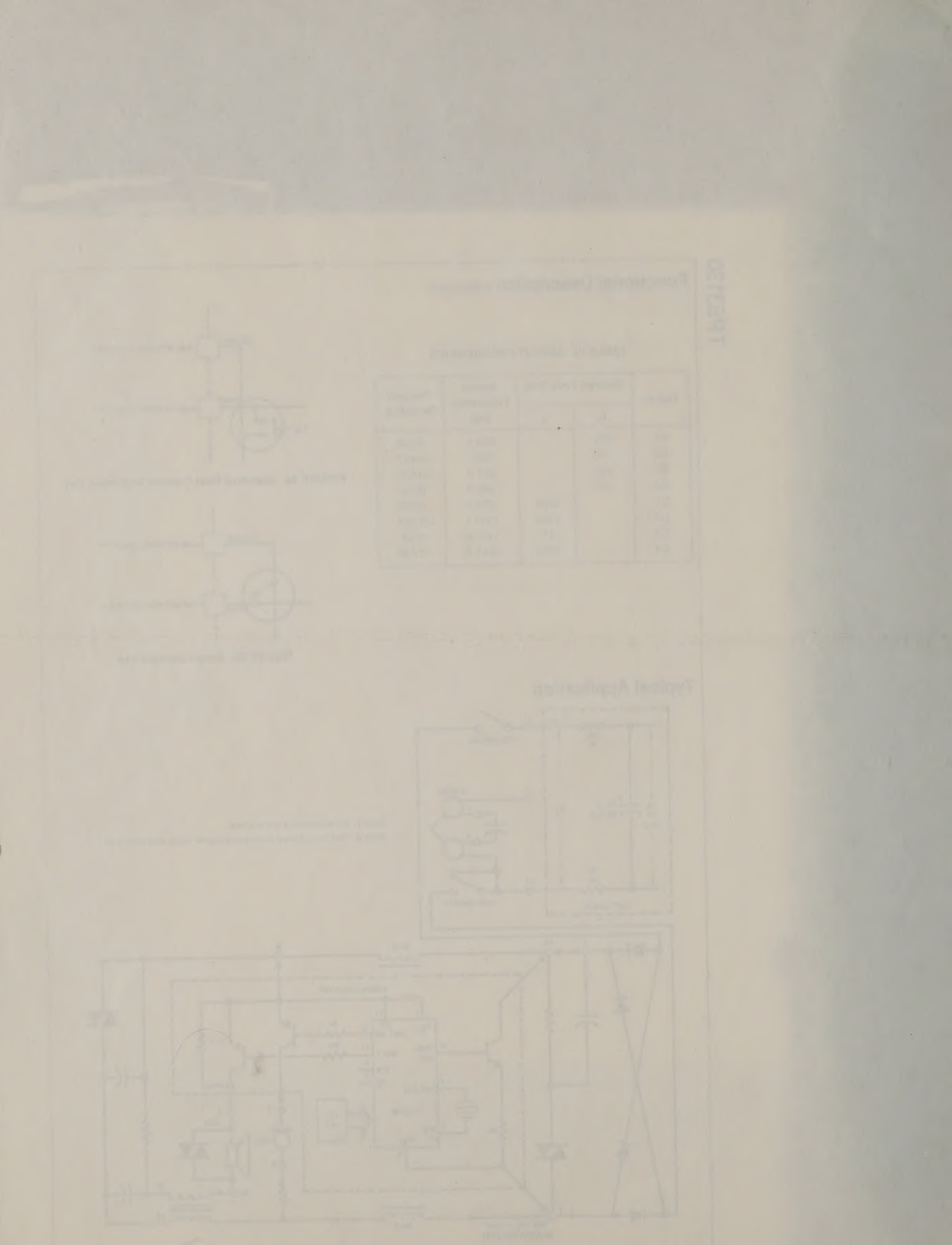


FIGURE 5



4200 LINE CARD

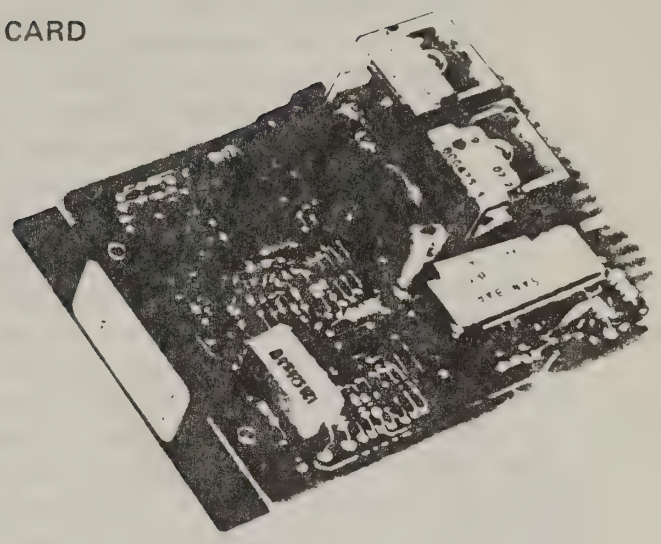


Fig. 1. SB4200 Line Card

1.0 GENERAL

1.1 This section provides circuit description, installation and basic testing information for the SAN/BAR 4200 Line Card.

1.2 The SAN/BAR 4200 Line Card (Fig. 1) is a simplified KTU line circuit designed for full compatibility with all types of key telephone systems working in conjunction with central office or EPBX/PABX equipment. In addition, the 4200 enables the caller to provide music on T and R to the party called when in the hold condition. Also, the 4200 can be optionally used with STC type interface connecting arrangements.

The issue 7 SB4200 Line Card has been issued to add the option of withstanding 50MS/500MS open loop prior to dropping the call. This is important since ESS offices may under some circumstances open the loop in a test made for 500MS.

2.0 SPECIFICATIONS

2.1 List of Applicable Drawings

Equipment Drawing: ED-4200-000 (Fig. 5) (Issue 7)
Schematic Drawing: SD-4200-000 (Fig. 4) (Issue 7)

2.2 Electrical Characteristics

a) Source voltage operates at 18V to 28V DC.
b) Operating environment temperature from 0°C to 50°C. Humidity to 90%.
c) Current Consumption: there is no idle current consumption. Maximum current consumption is 60 MA.
d) Loop Current: 20MA (minimum)
e) Ringing Voltage: Operates at 57V ringing signal; will not
f) Response Time: Guaranteed 200msec of ringing signal will trigger the ring-in circuitry.
g) Ringing Time Out: Two options are furnished either 5 to 9 or 12 to 20. (See schematic and option chart)
h) False Ringing: Line induced AC voltages will not cause false ringing-in.
i) Ringing Option: The unit includes an "STC signaling ringing" option by the use of "U" link and socket furnished. The unit is factory set for bridged ringing. (See schematic and option chart).
j) Parallel dialing: A remote two wire teiephone instrument dialing (on the central office side) will not cause false ringing-in.
k) Line Reversal: Unit operation is independent of line polarity.
l) Busy Light: A light emitting diode is provided to indicate a busy line condition.
m) Music on Hold: A band pass filter "H" pad is used to provide music on hold from either a low impedance source (4 to 16 ohms) or a 70.7 VAC music distribution source.

2.3 Physical Characteristics

a) Dimensions: 3.5"W x 4.75"L x 1.3"H Conforming to standard line card dimensions.
b) Weight: 7 oz. approximately
c) Key Location: Card must be keyed with slots between pin 5 and 6, and between

pin 12 and 13.

d) Pin spacing: 0.150 inches between centers

3.0 INSPECTION

3.1 Inspect the unit thoroughly, as soon as possible after delivery. If any part of the unit has been damaged in transit, report the extent of damage to the transportation company immediately. If the unit is to be stored for some time before installation, make an operational check at once. The purpose of this check is to make sure that the unit is in proper working order as received from the factory. If the check indicates satisfactory performance, the unit may be stored for future installation. If the system is to be installed at once, make an operational check after the installation is completed.

4.0 MOUNTING

SAN/BAR 4200 circuit card is the same physical size and has the same tap key and lock capability as the standard WE 400 line card or the SAN/BAR 4000 line card and will mount in any standard key service panel such as the SB319A. For mounting techniques see the SAN/BAR equipment mounting shelf brochure.

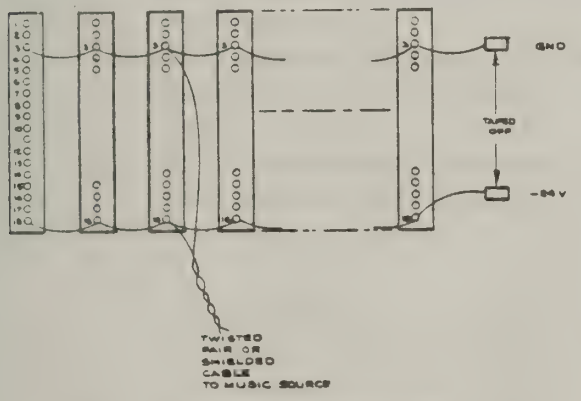
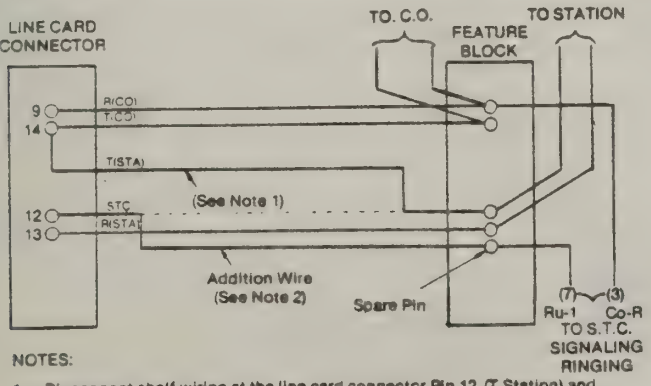


Fig. 2 Installation Information



NOTES:

1. Disconnect shelf wiring at the line card connector Pin 12 (T Station) and resolder to pin 14 of the line card connector.
2. Establish a new wire from pin 12 of the Line Card connector to a spare pin on the feature block.
3. Install "U" link per paragraph 5.4
4. Crossconnect S.T.C. signaling leads to the KS-20721 Station Coupler (S.T.C.) pins 7 and 3 as shown above.

Fig. 3 S.T.C. Signaling Ringing Installation

5.0 INSTALLER CONNECTIONS

5.1 The installer should be cautioned to be sure that the music-on-hold music source has a volume control independent of the volume control for the P.A. microphone and music system. An ideal music-on-hold music source is the SB4201A FM receiver on a KTU size circuit and that easily installs into the Key Service Panel. (See separate CD-4201-000).

For a pre-wired 584 Type Key Service Panel pin 3 of each line card connector will be wired together and connected to talk battery ground; pin 18 of each line card connector will be wired together and connected to talk battery. (See Fig.2) To wire in music-on-hold the installer needs only to disconnect the talk battery connections, sleeve them, and connect the music source to any pair of pins 3 and 18. However, if a SB319A Key Service Panel is used no internal wiring changes are required because pins 3 & 18 of each card position appear as a strap option on the rear of the 319A (See separate CD-0319-000).

Crosstalk may be encountered in some systems if wires carrying the music are tightly wrapped with other cabling in the system. It is, therefore most important to run all music carrying wiring loosely and separate from other wiring in the Key Service Panel.

Strap option J2 is provided to allow the use of a low impedance source in the "B" position of J2 and a high impedance 70.7 VAC music source in the "A" position.

5.2 The 4200 would ordinarily replace standard type line card.

5.3 In areas of high thunderstorm activity, the following information is offered:

Continued and extensive tests of line card failures due to ligtening damage indicates that the best protection is to have a separate earth ground (water pipe) for the KTU power supply and not to use an adjacent or easily available AC circuit ground for this purpose.

5.4 S.T.C. Signaling Ringing

Use the strap of socket J1 at RR for DC voltage ringing. Take the strap of socket J1 out (not use) for AC voltage ringing and see the wiring harness as shown in Fig. 3 for additional card cage wiring changes to accomodate S.T.C. signaling.

5.5 Open Loop Time Constant

J8 strap options provide the user with the option of a fast or slow loop release. Normally a line card will drop the loop within 50MS for all but cases where the card is associated with

a ESS office. In this case, J8 should be strapped to maintain a connection through a 500MS open loop, which a ESS office will do when testing loops.

6.0 CIRCUIT DESCRIPTION

Please refer to Figure 4 for this description.

6.1 Idle Condition

All transistors are off, and all relays are released and in the position indicated in the schematic. No current is drawn in this mode.

6.2 Incoming Call

An incoming call will apply ringing voltage to T (C.O.) and R (C.O.) and this is rectified in the bridge CR 1 - CR 4 to operate K 3 relay through coil R. Contact K 3 closes and applies positive potential through R 32 to the base of Q3. Q3 applies negative potential to the base of Q1 through R5 and R8 and Q1 conducts to energize K1. Contacts K1-A through K1-F operate to afford the following functions:

a) K1-F connects line card pin 5 and 6 (ST and LG) to start the interrupter.
b) K1-E connects lamp flash (pin 7) to lamp (pin 8) and line button on teleset flashes.
c) K1-D connects ring control voltage (pin 1) via pin 11 to bell/buzzer in teleset.
d) K1-C prepares Q1 for switching to the non-conductive state.
e) K1-B prepares for the hold condition in coincidence with the K1-A and K2-E contacts.
f) K1-A assures complete isolation of the music system during the talk condition of the card.

Transistor Q6 provides an additional relay contact to apply the timeout capacitor, C14, to maintain a hold condition for open loops of 50 or 500 milliseconds. Zener CR13 assures that Q6 turns off before K1 drops out.

6.3 Abandoned Call:

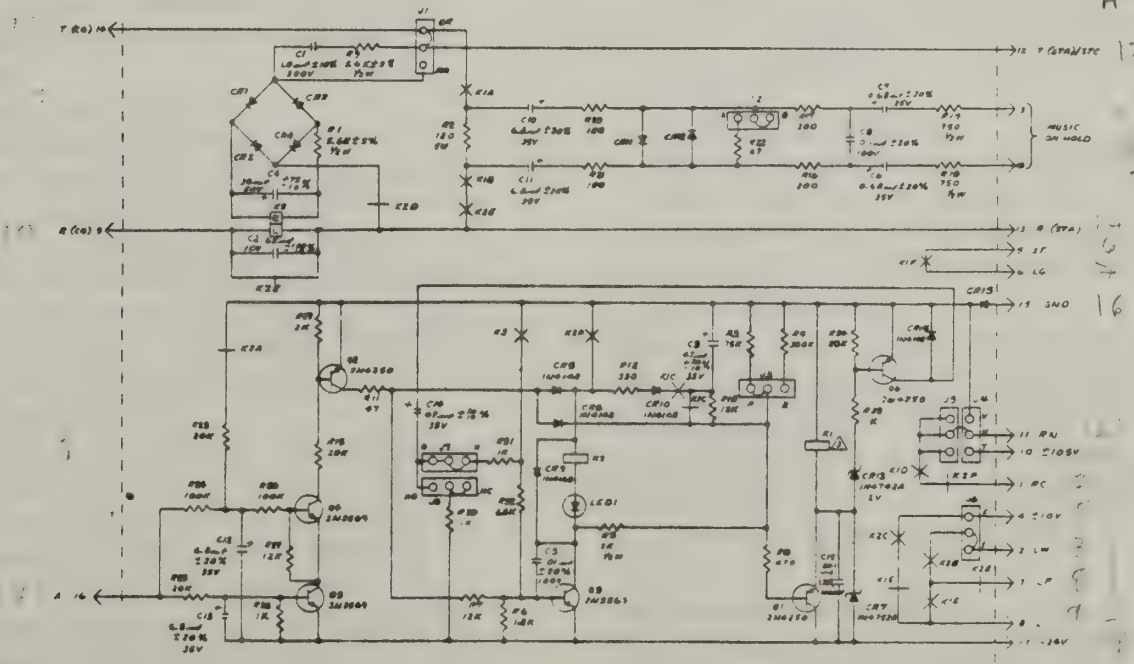
If the incoming ringing ceases, due to the caller hanging up, resistor R3 or R4 determines the timeout charge of C3 and the hold-over time before relay K1 releases.

6.4 Call Answered

When the line button has been depressed and the handset goes off-hook a ground is applied to pin 16. Transistor Q5 turns on after a short timeout determined by R25, R28 and C13. Transistor Q4 is pre-biased through the normally closed (N.C.) K2-A contact and R23 so that Q4 turns on as soon as Q5 supplies bias to the emitter of Q4. With Q4 and Q5 on, Q2 turns on and supplies a ground to the anodes of CR5 and CR6. In addition, the ground through R7 operates Q3, the ground through CR5 operates the K2 relay, and the ground through CR6 forces off Q8 which releases the K1 relay. Relay contacts K2-A through K2-F operate and afford the functions indicated below:

a) K2-A applies an alternate ground to the K2 relay to hold it if Q2 is released when the A lead is opened in the hold condition.
b) K2-E connects R2 to ring line to prime for hold condition if and when K1-B and K1-A close later. K2-E contact removes short condition from K3 (L winding) and loop current energizes L winding.

KTU CARD "A" SCREW



c) K2-D removes the ring detect circuit.
d) K2-F breaks ringing control voltage from the bell/buzzer circuit.
e) K2-B breaks lamp flash.
f) K2-C gives lamp steady state.

The telephone circuit is now established and a telephone conversation effected. The line button lamp will be steadily illuminated until the subscriber goes off the line.

6.5 Call Placed On Hold

Depressing the red hold button removes the ground at pin 16. Q5 turns off, turning off Q2, which removes the ground at the anodes of CR5 and CR6. Relay K2 is held operated by contact K2-A and Q3. Transistor Q3 remains on because loop current through the K3-L winding keeps contact K3 closed, which maintains Q3 through R32. With the ground removed from the anode of CR6, Q1 is turned on through R5 and R8, which operates K1 to apply R2 across the tip and ring. Any music impressed across R2 may now be heard by the distant party. With R2 bridged across the tip and ring, loop current will continue to flow through K3-L after the pickup key is released. The time constant formed by R24, R26, and C12 assure that a momentary grounding of pin 16 while the hold button is released will not force the line card out of hold. It also assures that a pulse will not be generated across the tip and ring (dial-one pulse) when retrieving the call from hold. Should the Central Office open the loop intermittenly, the line card will remain in hold for 10,50 or 500 milliseconds, depending on the strap option selected. The time constant is determined by C14, R31 and R32 or R30.

6.6 Call Abondoned on Hold.

In the event that the calling or distant party hangs up or otherwise abandons a call when the telephone circuit is in a hold condition, the flow of loop current ceases. The relay K3 is accordingly de-energized and the consequent opening of the contact K3 starts the timeout of C14, R31 and R32. At the end of the timeout, Q3 turns off and releases K2 and K1.

6.7 Music on Hold Circuit

R18, R19, C6, C7 and C8 form a low pass filter. R20, R21, R2, C10 and C11 form a high pass filter. Together they form a band pass filter with a pass band of from 300 to 3000 Hz. Diodes CR11 and CR12 provide amplitude limiting and R22 is used to provide additional attenuation when the music source is 70.7VAC rather than the usual 8 ohm source.

7.0 TESTING

7.1 If trouble is encountered with the operation of the 4200 line card, check that all installer connections and strappings have been properly made. Make certain that the 4200 unit is making good connection with the mounting assembly card connector, snap the 4200 out and in several times.

7.2 If the trouble persists use the procedure in 7.3 to determine a bad line card or a bad system.

7.3 Using a multimeter (Simpson 262 or equiv.) test the 4200 as follows:

a) Connect the multimeter (set to the 60V DC scale) across pin 15 (GRD) and pin 17 (-24V) of the card connector. The multimeter should indicate + 24 ± 4 VDC.
b) Connect the multimeter (set to the 60V DC scale) across pin 16 (GRD) and pin 17 (- 24V) of the card connector, in the answer mode. The multimeter should indicate + 24 ± 4V DC.
c) Connect the multimeter (set to the 15V AC scale) across pin 4 (± 10V) and pin 6 (LG) of the card connector. The multimeter should indicate 10 ± 2V AC.
d) Take the 4200 off the card connector, set the multimeter to the R x 100 ohm scale and measure across pin 12T (STA) and pin 13R (STA) of the 4200 line card. The multimeter should indicate infinity (00).
e) Measure the coil resistance of K1, K2 and K3 on the 4200 line card, (set the multimeter to the R x 100 ohm scale). The resistance of K1 K2 winding should measure 750 ohms + 10%, R winding of K3 should measure 1600 ohms ± 10% and L winding of K3 should measure 70 ohms ± 10% on the meter.
f) Check the Music Source:
Connect the multimeter (select the VAC scales: from 150V AC to 25V AC) across pin 3 (MOH) and pin 18 (MOH) of the card connector. The multimeter should kick at the 2.5V AC scale.

7.4 Field repairs involving replacement of components within a module are not recommended. All San/Bar products are warranted for 2 years from the date of purchase. Return to San/Bar Corporation, P.O. Box 2225/2405 S. Shiloh Rd., Garland, Texas 75041

For technical assistance call:
Texas & Outside U.S.A. (214) 840-2710
Outside Texas 1-800-527-4837

REVISIONS			
LTR	DESCRIPTION	DATE	APPROVED
M	SEE DCN 0458	6/21/74	

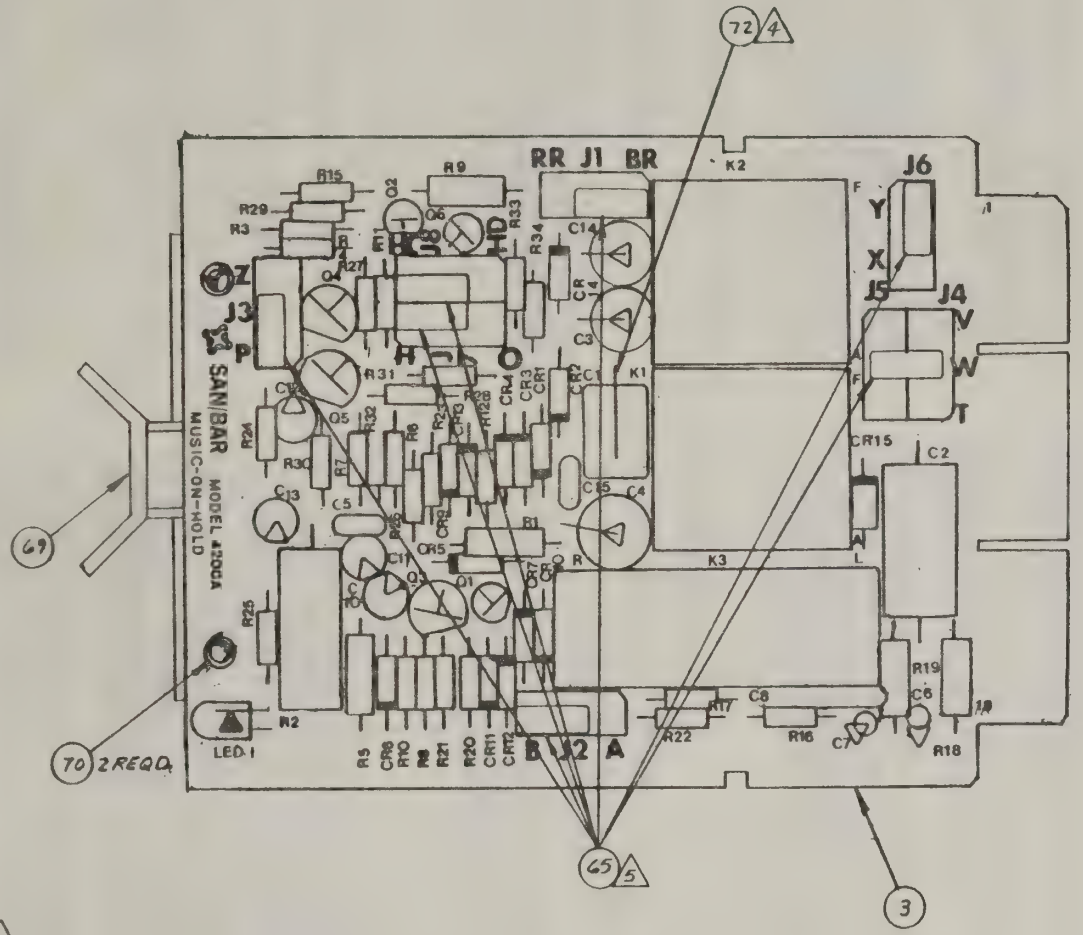


FIGURE 5

5 ASSY TO BE SHIPPED WITH ITEM 65 IN POSITIONS SHOWN

4 SLEEVE TOP LEAD OF C1 (MAX HT AFTER SLEEVING = 1.30)

3. △ DENOTES POSITIVE END OF CAPACITORS

2. COMPONENTS MAY BE FLOW SOLDERED

1. K1, K2 & K3 TO BE HAND SOLDERED AFTER FLOW SOLDERING

NOTES UNLESS OTHERWISE SPECIFIED

SEE SEPARATE BM-4200-000

DASH NO	NEXT ASSY	USED ON
	APPLICATION	

UNLESS OTHERWISE SPECIFIED
DIM IN INCHES
TOLERANCES
X ± 1
XX ± .03
XXX ± .010
ANGLES ± 0°5'
MACH FIN √
BREAK ALL SHARP EDGES AND CORNERS

CONTR NO		
DR J. MILLER 6-21-74	ENG	
CHK [illegible]	PROJ	
DSGN	REL	
APPD		

SAN / BAR CORP.
17422 PULLMAN STREET SANTA ANA, CALIFORNIA 92705

EQUIPMENT DWG - LINE CARD WITH MUSIC-ON-HOLD (ISS.7) MODEL 4200A

SIZE	CODE IDENT NO.	DWG NO.	LTR
C	27412	ED-4200-000	M

SCALE 2/1 SHEET 1 OF 1

NORTH SUPPLY CO. 10951 LAKEVIEW AVE.
ORDER PART NUMBER → S-435742 LENEXA, KANSAS 66219
(phone: 1-913-888-9800 1-800-255-0404)

K400TPL INTERFACE LINE CARD (B60049-1000)

1.00 GENERAL

1.01 The K400TPL INTERFACE LINE CARD is a Key Telephone Unit (KTU) plug-in CO/PBX line circuit with interface circuitry. The K400TPL permits direct connection to be made to a telephone company (telco) line facility. The interface circuitry maintains longitudinal balance on a telephone line while providing direct current (DC) isolation. Each card has a light emitting diode (LED) as a card status indicator to facilitate servicing the Key Telephone System (KTS).

1.02 The K400TPL is equipped with three jumper block/plug arrangements to provide the following options:

a. short time out (5-10 seconds),
b. interrupted ringing,
c. auxiliary common audible signal, and
d. music-on-hold.

NOTE: **MUSIC-ON-HOLD REQUIRES ADDITIONAL EQUIPMENT.**

1.03 The short time out option reduces the time out of a card from 25-35 seconds to 5-10 seconds when a calling party abandons a call prior to it being answered.

1.04 The K400TPL *does not* contain any power failure transfer circuitry. However, the Power Failure Transfer Card (B60052-0000) can be used in conjunction with a K400TPL Line Card to transfer a CO line to an emergency line, or an emergency telephone, in the event of local power failure. The Power Failure Transfer Card is not automatically shipped with the Interface Line Card; it must be ordered separately.

1.05 The K400TPL is registered with the FCC under the following number:

AS293P-67342-VP-E
Ringer Equivalence 0.4B

The VP Classification gives the K400TPL Interface Line Card fully protected status. *Any* key service unit requiring 400-type line cards can be used behind the K400TPL Line Card. Therefore, the K400TPL Interface Line Card *replaces* the K400TP and K400TP/TPL line cards because of its *less restrictive* classification.

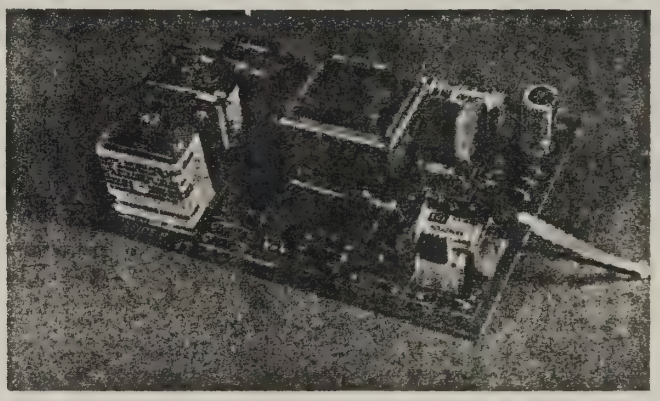
2.00 LIMITATIONS

2.01 The K400TPL is interchangeable with the K400E line card except for the following features:

a. The K400TPL line card *does not* provide a steady illuminated lamp on *hold* (X Option).
b. The card *remains* on *hold* a *held* party abandons the call.
c. Central Office (CO) ringing *cannot* be bridged across the station TIP/RING leads.
d. If the A-lead is not grounded prior to bridging the CT/CR leads during troubleshooting, the Interface Line Card *will* go on continuous hold.

3.00 SPECIFICATIONS

3.01 The TIP/RING bridged impedance allowance is approximately ten times the minimum allowance.



3.02 The response time to a CO ringing signal is 100 to 200 milliseconds to avoid false ringing.

3.03 The normal time out of the card, when a calling party abandons a call before it is answered, is 25-35 seconds, or 5-10 seconds with the short time out option.

3.04 The K400TPL Line Card is environmentally tested to ensure reliability. Each unit shall be able to withstand ten repeated 24-hour tests consisting of two high cycles of 4.5 hours @ 55°C and 95% relative humidity without condensation, and one low cycle for 4.0 hours @ −10°C. Each cycle must return to a reference temperature of +18°C.

4.00 ORDERING

4.01 The card is ordered as follows:

K400TPL INTERFACE LINE CARD
Part Number B60049-1000

4.02 The power failure transfer unit is ordered as follows:

POWER FAILURE TRANSFER CARD
Part Number B60052-0000

5.00 INSTALLATION

5.01 The K400TPL Interface Line Card is installed one card per CO line required. The unit plugs into mounting connectors provided in the Key Service Unit (KSU), with the printed circuit side to the installer's left, (K1A2 KSU), or on the bottom (K36A and K76A KSU).

5.02 It is important that the KTU is plugged into the card holder firmly. Some KSU's include a Retaining Bar to ensure that the KTU's are held in position. Loosen and remove the Retaining Bar before installing the KTU's; insert the card(s), then install the Retaining Bar and tighten the two attaching screws securely.

5.03 The mounting connectors provide contact points for the inputs and outputs of the K400TPL. Some pin functions are common by a bare wire strap across the back of the mounting connectors.

***CAUTION:* PIN 18 ON THE MOUNTING CONNECTOR MAY PROVIDE −24V FILTERED (A BATTERY). THIS CONNECTION MUST BE REMOVED TO AVOID POSSIBLE CIRCUIT DAMAGE TO THE K400TPL CARD.**

5.04 To remove an unwanted strap connection, as with Pin 18 in earlier KSU's, cut and remove the bare wire strap from the back of each mounting connector to be used. *ONLY* remove the bare wire strap and not the insulated conductor.

5.05 Pin functions of each mounting connector are brought out to the back of the KSU cabinet via a wiring harness. Depending on the KSU, the wiring harness either terminates on punch down blocks, or in 25-pair male plugs. From the blocks or plugs, individual CO line functions must be brought out of the KSU cabinet and terminated on KSU Blocks, mounted on the Main Distribution Frame (MDF), in accordance with manufacturer's instructions.

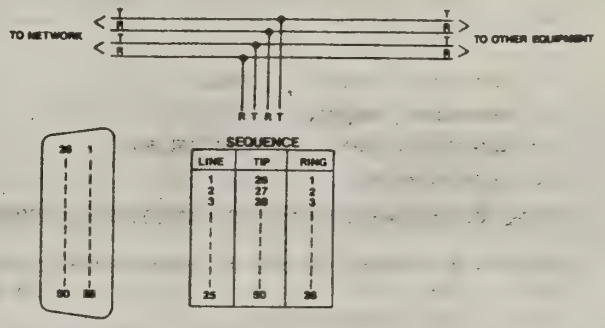
5.06 From the KSU Blocks, station CO line functions are cross connected to other system connection blocks, and necessary functions taken back to the station equipment. It is also from these blocks that CO/PBX TIP and RING functions are brought out to the telco provided equipment.

5.07 The telco will provide final network connection via a miniature 6-position jack, or a 50-position miniature ribbon jack. These mechanical arrangements are for single line and multiple line bridged TIP and RING electrical network connections respectively.

5.08 The miniature 6-position jack must be ordered by the customer from the telco under the Universal Service Order Code (USOC) designation **RJ11C** (RJ11W for portable wall mounted equipment). Conductors 1, 2, 5, and 6 are reserved for telco use; thus, conductors 3 and 4 are reserved for CO RING and CO TIP, respectively. The customer must provide a miniature 6-position plug, to complete the connection, with CO RING on position 3, and CO TIP on position 4. The cable attached to the plug shall terminate inside the KSU cabinet as a direct connection, and shall not be in excess of 25 linear feet.

***NOTE:* THE 25 LINEAR FEET REQUIREMENT SHALL INCLUDE THE CABLE COMING FROM THE KSU CABINET TO THE KSU BLOCKS; THUS, THE LENGTH OF THE CABLE FOR THE CUSTOMER PROVIDED MINIATURE 6-POSITION PLUG MUST BE ADJUSTED ACCORDINGLY.**

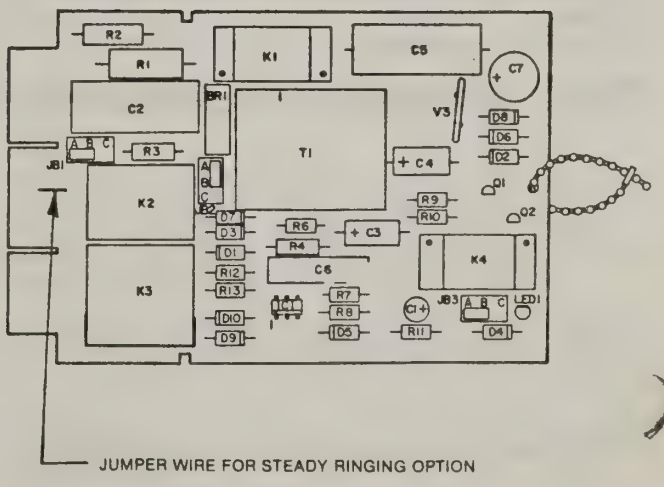
5.09 The 50-position miniature ribbon jack must be ordered by the customer from the telco under the Universal Service Order Code (USOC) designation **RJ21X**. At the time the jack is ordered, the customer must specify the sequence in which the CO lines are to be connected to the jack. The telco will consecutively wire these lines to the jack as shown below without skipping any positions.



5.10 The customer must provide a 50-position ribbon plug, complete the connection, with CO TIP and CO RING for each li... in the same sequence. The cable attached to the ribbon plug shall terminate inside the KSU cabinet as a direct connection, and shall not be in excess of 25 linear feet (see note above).

JUMPER BLOCK ARRANGEMENT

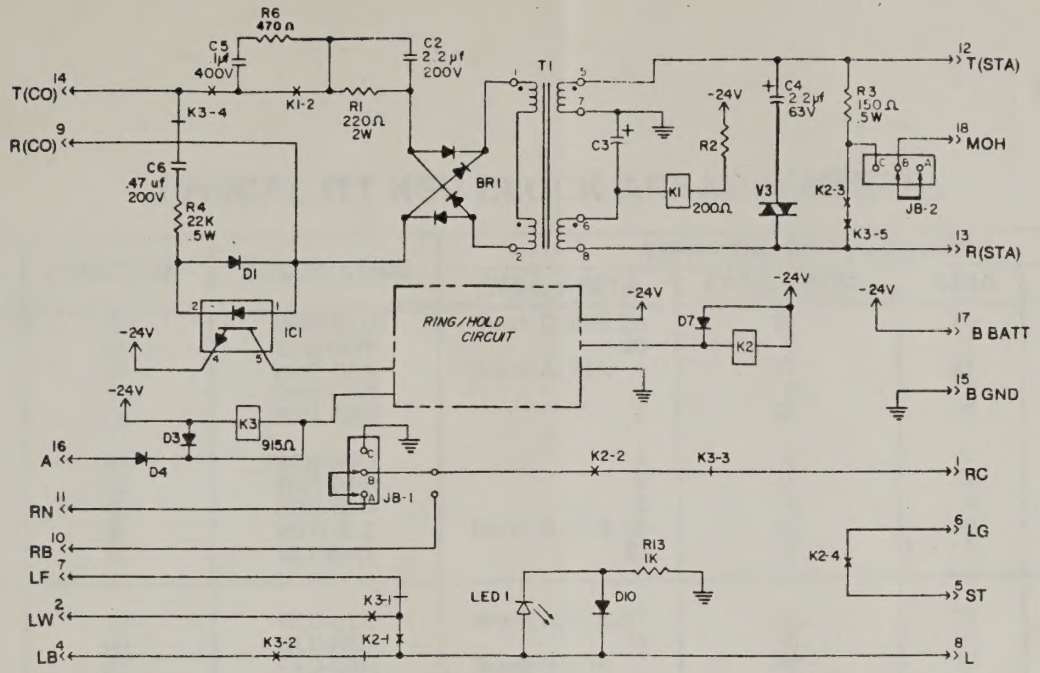
OPTION	JB1	JB2	JB3	COMMENTS
Short Time Out (Z)			AB	Factory Standard
Long Time Out			BC	
Standard "HOLD" (No Music)		AB		Factory Stndard
Music-On-Hold (M)		BC		SEE NOTE 2
Auxiliary Common Audible Signal Control (V)	BC			
Interrupted Ringing (W)	AB			Factory Standard
Steady Ringing (T)	Remove Plug			SEE NOTE 1



NOTES:

1. For Steady Ringing Option, Solder a Jumper Wire on the PC Board Assembly as Indicated.

2. For MUSIC-ON-HOLD option, wire a K403A output between Tab 12 (CT) and Tab 18 (MOH).



6.00 CIRCUIT DESCRIPTION

6.01 AC ringing voltage from the Central Office (CO) is applied to the CO TIP/RING **(Tabs 14 and 9)**. Current flows via contact K3-4, C6, R4, and the LED portion of photo coupler IC-1 during negative cycles of the applied AC ringing voltage. During the positive cycles of ring voltage, current flows via contact K3-4, C6, R4, and D1, protecting the LED against reverse voltages. During the half cycles of ringing when current flows through the LED portion of IC-1, the phototransistor section is activated and applies −24V DC to **RING/HOLD** circuit. The **RING/HOLD** circuit activates Relay K2. Contact K2-2 then connects the ringing voltages or signals to the RINGER LEAD **(Tab 1)**. Voltage from **GND (Tab 11)** may be selected by jumper block/plug **JB1**. If steady ringing is required, then solder a jumper wire as shown in the diagram to route the ring battery at **Tab 10** to K2-2. Contact K2-1 connects the LAMP FLASH VOLTAGE **(Tab 7)** to the LAMP LEAD **(Tab 8)** via inactive contact K3-1. Contact K2-4 connects **LG (Tab 6)** to the interrupter motor start **[ST] (Tab 5)**, thus starting the key system interrupter.

6.02 The called party answers the telephone by taking the handset off-hook, either before or after depressing the line button associated with the incoming call. With the telephone off-hook and the button depressed, a sequence of two events occurs.

6.03 First, GND is connected to the A-lead **(Tab 16)** via the A-lead contact in the line button of the telephone. The presence of GROUND **(Tab 16)** activates Relay K3. The **RING/ HOLD** circuit now deactivates K2. Ringing signals, or voltages, are removed from **Tab 1** via the contacts K2-2 and K3-3. LAMP BATTERY **(Tab 4)** is connected to the LAMP LEAD **(Tab 8)**; and LAMP FLASH **(Tab 7)** is removed via contacts K3-2 and K2-1. Contact K3-4 removes the CO TIP/RING connection **(Tabs 14 and 9)** from the ring detector circuit and connects them to de-energized contact K1-2. Contact K2-4 opens, thus stopping the interrupter motor.

6.04 The second event is the connection of station TIP and RING **(Tabs 12 and 13)** to the subset. Current flows from GROUND through windings 5-7 of T1, the off-hook subset, windings 6-8 of T1, the coil of relay K1, and R2 to −24V DC. K1 now activates. Contact K1-2 completes the CO TIP/RING path to the isolation transformer T1 circuit. CO current now flows from CO TIP **(Tab 14)**, through contact K3-4, contact K1-2, R1, and transformer windings 1-2 via bridge rectifier BR1 to CO RING **(Tab 9)**. This DC current flow trips CO ringing. C2 provides an AC bypass around R1. Voice signals are coupled via T1 between the CO line and the called party.

6.05 When the subset hold button is depressed, the A-lead contact **(wired to Tab 16)** is broken before the TIP and RING contacts. When the GROUND is removed from **Tab 16**, K2 operates. R3 is connected across T(STA) and R(STA) via contacts K3-5 and K2-3 to provide a current path to keep relay K1 operated when the subset TIP and RING connection is broken. K1 maintains the CO TIP/RING connection via contact K1-2. Contact K2-1 removes the LAMP LEAD **(Tab 8)** from the LAMP BATTERY INPUT **(Tab 4)**, and substitutes the LAMP WINK SIGNAL **(Tab 2)** via energized contact K3-1.

6.06 When the subset line button is depressed to go off *hold*, relay K2 is deactivated. Contact K2-1 removes LAMP WINK **(Tab 2)** and re-establishes LAMP BATTERY **(Tab 4)** to the LAMP LEAD **(Tab 8)**. The K2-3 contact removes resistor R3 from the station TIP/RING circuit. Since the TIP/RING line button contacts have closed, the current path that keeps relay K1 operating remains unbroken.

6.07 When a line button is depressed to initiate a call, the A-lead is grounded operating relay K3 via **Tab 16**. Contact K3-2 connects LAMP BATTERY **(Tab 4)** to the LAMP LEAD **(Tab 8)** for a steady visual signal on all associated subsets. Contact K3-4 provides one of the connections necessary to draw central office current via CO TIP/RING **(Tabs 14 and 9)**. When the subset line button connects station TIP and RING **(Tabs 12 and 13)** to the subset, relay K1 operates via R2 and the windings of T1. Contact K1-2 completes the CO DC circuit through T1 winding 1-2 and R1 via the CO TIP/RING **(Tabs 14 and 9)**. Dial tone is now sent from the CO.

6.08 During dialing, the subset TIP/RING circuit is pulsed off/on by the action of dial contacts. Relay K1 follows this off/on pulsing and repeats this action to the CO via contact K1-2. R6 and C5 suppress noise and arcing during the pulsing of contact K1-2.

***NOTE:* IF THE SUBSET IS EQUIPPED WITH A TONE DIAL PAD, THE GENERATED TONES ARE COUPLED VIA T1 TO THE CO DECODING CIRCUITS.**

6.09 MUSIC-ON-HOLD (MOH) is provided by connecting a music source between **Tabs 12 and 18**. The music signal can be connected to R3 via the jumper block/plug JB2. When the circuit is placed on hold, contacts K2-3 and K3-5 connect the music signal to T1 which couples the signal to the telephone line.

6.10 An LED is provided to give visual status indication to service/repair personnel. D10 protects the LED during negative half cycles of the incoming 10V AC lamp signals, and R13 limits the LED current.

6.11 D3 and D7 suppress inductive voltages when relays K3 and K2 are de-energized.

6.12 Bridge rectifier BR1 polarizes CO line current.

TYPICAL ITT KSU BLOCK ARRANGEMENTS

LINE	FUNCTION	COLOR CODE	TERMINAL OR PIN NUMBER			
			K501, K501A	K512, K512A	K36A	K76A
1	T1	WHT-BLU	Block C, Pos. 25	26	26	PLUG P1-26
	R1	BLU-WHT	26	1	1	PLUG P1-1
	1T	WHT-ORN	Block A, Pos. 1	27	27	PLUG P1-27
	1R	ORN-WHT	2	2	2	PLUG P1-2
	1A	WHT-GRN	3	28	28	PLUG P1-28
	A1	GRN-WHT	4	3	3	PLUG P1-25
	LG	WHT-BRN	5	29	29	PLUG P2-25
	1L	BRN-WHT	6	4	4	PLUG P1-3
	B	WHT-SLT	Block B, Pos. 19	30	30	PLUG P4-47
	R	SLT-WHT	20	5	5	PLUG P1-29
2	T2	RED-BLU	Block C, Pos. 27	31	31	PLUG P1-4
	R2	BLU-RED	28	6	6	PLUG P1-30
	2T	RED-ORN	Block A, Pos. 7	32	32	PLUG P1-5
	2R	ORN-RED	8	7	7	PLUG P1-31
	2A	RED-GRN	9	33	33	PLUG P1-6
	A1	GRN-RED	10	8	8	PLUG P1-25
	LG	RED-BRN	11	34	34	PLUG P3-50
	2L	BRN-RED	12	9	9	PLUG P1-32
	B	RED-SLT	Block B, Pos. 21	35	35	PLUG P4-47
	R	SLT-RED	22	10	10	PLUG P1-7
3	T3	BLK-BLU	Block C, Pos. 29	36	36	PLUG P1-33
	R3	BLU-BLK	30	11	11	PLUG P1-8
	3T	BLK-ORN	Block A, Pos. 13	37	37	PLUG P1-34
	3R	ORN-BLK	14	12	12	PLUG P1-9
	3A	BLK-GRN	15	38	38	PLUG P1-35
	A1	GRN-BLK	16	13	13	PLUG P1-25
	LG	BLK-BRN	17	39	39	PLUG P3-25
	3L	BRN-BLK	18	14	14	PLUG P1-10
	B	BLK-SLT	Block B, Pos. 23	40	40	PLUG P4-47
	R	SLT-BLK	24	15	15	PLUG P1-36
4	T4	YEL-BLU	Block C, Pos. 31	41	41	PLUG P1-11
	R4	BLU-YEL	32	16	16	PLUG P1-37
	4T	YEL-ORN	Block A, Pos. 19	42	42	PLUG P1-12
	4R	ORN-YEL	20	17	17	PLUG P1-38
	4A	YEL-GRN	21	43	43	PLUG P1-13
	A1	GRN-YEL	22	18	18	PLUG P1-25
	LG	YEL-BRN	23	44	44	PLUG P4-27
	4L	BRN-YEL	24	19	19	PLUG P1-39
	B	YEL-SLT	Block B, Pos. 25	45	45	PLUG P4-47
	R	SLT-YEL	26	20	20	PLUG P1-14
5	T5	VIO-BLU	Block C, Pos. 33	46	46	PLUG P1-40
	R5	BLU-VIO	34	21	21	PLUG P1-15
	5T	VIO-ORN	Block A, Pos. 25	47	47	PLUG P1-41
	5R	ORN-VIO	26	22	22	PLUG P1-16
	5A	VIO-GRN	27	48	48	PLUG P1-42
	A1	GRN-VIO	28	23	23	PLUG P1-25
	LG	VIO-BRN	29	49	49	PLUG P4-28
	5L	BRN-VIO	30	24	24	PLUG P1-17
	B	VIO-SLT	Block B, Pos. 27	50	50	PLUG P4-47
	R	SLT-VIO	28	25	25	PLUG P1-43

Printed in USA

ITT TERRYPHONE CORPORATION
Post Office Box 4038, Harrisburg, PA 17111